

Social Network Analysis of the Caste-Based Reservation System in India

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Abstract. It has been argued that the reservation system in India, which has existed since the time of Indian Independence (1947), has caused more havoc and degradation than progress. This being a popular public opinion, these notions have not been based on any rigorous scientific study or research. In this paper, we revisit the cultural divide among the Indian population from a purely social networks based approach. We study the reservation system in detail, starting from its past and observing its effect on the people. Through a survey, we analyze the variation in behavioural characteristics exhibited towards members of the same caste group versus members from another caste group. We study the distinct cluster formation that takes place in the Indian community, and find that this is largely due to the effect of caste-based homophily. To study the social capital associated with each individual in the backward class, we define a new parameter called social distance. We study the changes that take place with regard to the average social distance of a cluster as well as network formation when a new link is established between the clusters which in its essence, is what the reservation system is accomplishing. Our extensive study calls for the change in the mindset of people in India. Although the animosity towards the reservation system could be rooted due to historical influence, hero worship and herd mentality, our results make it clear that the system has had a considerable impact in the country's overall development by bridging the gap between the conflicting social groups.

Keywords: Social Networks, Caste, Indian Reservation System, Social Capital

Introduction

The Caste System in India

In the context of the Indian society, caste is defined to be a Hindu hereditary class of socially equal persons, united in religion and usually following similar occupations, distinguished from other castes in the hierarchy by its relative degree of spiritual purity or pollution[1].

It is said that the origin of the caste system is credited to the *Vedas*, the mythological texts that claim the very basis of Hindu religion, according to which, the primal man destroyed himself to create a human society. The different castes were created from different parts of his body. The Brahmins (scholar or priest class) were created from his head; the *Kshatrias* (soldier class) from his arms; the *Vaishias* (business class) from his thighs and the *Sudras* (menial labour class) from his feet. The hierarchy in the caste is determined by the descending order of importance of his body organs.

Another religious theory claims that the caste system was created from the body organs of Brahma, who is believed to be the creator of the world according to the Hindu religion. This stratification, though an obvious myth, has stayed in the Indian society since time immemorial.

Economic Impact of the Caste System

Although the caste groups were supposedly divided along the lines of spiritual purity, they soon came to determine inflexible occupational roles. The downside of this system surfaced with the birth of caste-based discrimination, which is still a dominant phenomenon today. As time progressed, one's caste became intrinsically linked with one's wealth, social status and even entry into public places. The society became largely dominated by the so called upper castes, and the rest were denied economic freedom, forced to work menial jobs and were prevented from trying to improve their economic status. This led to the concentration of assets, social capital and power in the hands of one section of the society. Therefore, while the socially forward classes progressed, the socially backward classes lagged behind in terms of literacy rates, education rates, income levels and other measures of socio-economic well-being.

The Reservation System in India from a Network Theory Perspective

To offset this practice of discriminatory social stratification, affirmative steps were undertaken to uplift the backward classes, and the reservation system was introduced wherein a certain number of seats were reserved for members of socially and economically backward classes at places of higher education and government jobs. However, it was soon met with a lot of backlash from the socially forward community, who felt that this system was not meritorious, and provided an undue advantage to members of the socially and economically backward classes.

In this paper, we study the existing system from a network theoretic perspective. We study the two social communities, the *socially forward and uplifted* (FC) and the *socially backward and downtrodden* (BC). We establish why and how the reservation system maintains a very good balance between the two, and is only taking the country further every day. Primarily, we justify the need for this system to continue to exist in present day India, by means of a simple survey, and by gathering certain relevant data from a nation-wide census. The

mathematical model aids us in finding parameters, which quantify upliftment and betterment of the country. In addition, we consider the number of links between the two communities as a measure of stability of the large scale social structure. We study the cumulative social capital of the backward classes in discrete time steps and observe how it changes when this system is in place.

Our motivation comes from the existence of a tangible strength associated with every weak tie, as proposed by Mark S. Granovetter in his famously cited theory of the Strength of Weak Ties [2]. This is a very prominent network phenomenon that has been ignored in past studies of this system, which we have chosen as our key element of study.

Past studies in network analytics by Matthew O. Jackson has shown that network formation and subsequent interaction between the nodes is highly influenced by homophily [26]. In India, associations amongst the people is seen to be largely determined by caste-based homophily, hence, for the purposes of our study, we choose to term the network formation pattern among the Indian population as a *caste-based homophilic network*.

We have studied this phenomenon using a simple survey, in which we found that majority of the friendship links existed within the same caste groups, as depicted in Table 1. The survey was conducted among 150 subjects, all of whom were between 20 and 40 years of age, and comprised of an equal distribution between members of both forward and backward castes. Such a network structure and the resulting non-cooperative behavior is one of the major reasons for discrimination, which is detrimental to harmonious growth of the country.

In this paper we consider a modified but natural model, where it is common knowledge that the state of the world changes deterministically over time, as new network connections are added through time steps. As our main contribution, we introduce in this paper the prominent role played by strength of weak ties in alleviating the divide between the caste groups in the Indian scenario. By our network model, we find it sufficient to insert a minimal number of links between the two clusters, in order to foster harmonic relations between the two conflicting groups.

Table 1. Results of the Survey conducted among subjects of a similar demographic bracket to depict friendship ties : Each subject was asked to name four close friends and their social groups

Criteria	Percentage of Survey Population
All four ties from within the same social group	62
Three ties from the same social group	22.3
Two ties from the same social group	7.7
One tie from the same social group	4.4
All ties from different social groups	5.5

As a long term aim of the reservation system, we see a reasonable balance of benefits distributed evenly among members from the forward as well as the backward communities. However, the current statistics show a clear tip in the balance favoring the socially forward community, with a majority of the country's shared resources such as education, wealth and land-holdings being in the possession of or being accessible to only one section of the society. This undesirable disparity can be seen as the result of many recent studies in this matter, including the works of A. K. Shiva Kumar and Preet Rustagi [5], Mona Sedwal and Sangeeta Kamat [6] and R R Biradar [7]. Hence, on studying this system in detail, analysing the changes in individual benefits that result due to addition of edges between the clusters through the reservation system and watching the strength of weak ties in play in propagating benefits even to those who do not directly benefit from the Reservation System, we note a number of striking changes that arise in individual welfare.

The effect of the absence of the system cannot be studied in the present day scenario due to the extant and obvious reasons, however a similar study has been performed by Vani Borooah, Dubey K, Amaresh and Sriya Iyer [8]. The study took into account a social group within the country which was at the same social, educational and economic status as the Scheduled Castes (SC) and Scheduled Tribes (ST) in the pre-independence era. However, the condition of this group was observed to be the same if not worse during their study conducted in 2009, while members of the SC and ST were found to be at a much more elevated state, proving the efficiency of the Reservation System. Many such similar studies clearly show the tangible upliftment experienced by the Scheduled Castes and Scheduled Tribes, and such comparative studies along with extant evidence only bolster the claim that this system is indeed a beacon of hope for the social disparity in India.

In spite of being in a far better position than they were in the pre-independence era, the socially backward community is still disadvantaged with respect to institutions such as education and economy. Thomas E. Weisskopf notes in his paper [30] that there still exist unequal representations in educational institutions in terms of social class, with the forward community being dominant and occupying a majority of the seats in spite of being far fewer in terms of population[14,15]. The proportion of graduates from backward communities were also found to be extremely low [15]. On studying the performance in nation-wide examinations, it was found that a very small proportion of students belonging to backward classes performed on par with the students from forward classes[18]. On assessing the academic performance of the beneficiaries of reservation, it was found that only a minority of them manage to graduate degree programs and qualify as a graduate[21,22]. Another major issue that needs to be resolved is the incomplete filling up of reserved seats[18,19], which shows the overwhelming need to change the mind set of the socially backward community from opting for low paying daily wage labor to a secure educational degree. Most of these studies involved participants who were first time beneficiaries of reservation. Studies on reservation for second level beneficiaries[20] show that their performance is visi-

bly better than their social counterparts who are first level beneficiaries, leading us to conclude that reservation must indeed exist for at least two generations, if not more in order to show a marked improvement in status.

Preliminaries and Definitions

Let $G(V, E)$ represent the undirected social network under consideration, and $G_1(V_1, E_1)$ and $G_2(V_2, E_2)$ represent the induced subgraphs of G , where V_1 is the set of all BC nodes and V_2 is the set of all FC nodes. Therefore, $V_1 \cup V_2 = V$ and $V_1 \cap V_2 = \emptyset$. Let n_1 and n_2 be the shorthand notation for the number of individuals in the BC and FC respectively i.e. $|V_1| = n_1$ and $|V_2| = n_2$.

We define the edge set B as $(E - E_1 \cup E_2)$ i.e. B consists of precisely those edges $\{u, v\}$, where $u \in V_1$ and $v \in V_2$, we will henceforth address these edges as *bridges*.

The distance $d(u, v)$ between two nodes u and v represents the length of the shortest path between u and v . For each $u \in V_1$ i.e. a person belonging to BC, we define

$$d_u^* = \min \{k | \exists v \in V_2 \ni d(u, v) = k\}$$

Therefore, d_u^* is the minimum distance from node u at which it will find atleast one node of V_2 . We will refer to this parameter as the *social distance* of node u from the FC.

A path $\langle v_1, v_2, v_3, \dots, v_k \rangle$ is called an *entry path* if $v_k \in V_2$ and $v_i \in V_1 \forall 1 \leq i \leq k - 1$. Therefore, if $d_u^* = l$, then l is the length of the shortest entry path starting from node u .

Model

The homophily observed in the social structure under consideration is *selection* based [40] i.e. the common characteristics that bound people together are immutable, in this case it is the caste of an individual. What the Reservation System does in essence, is, it picks a BC individual and gets it in contact with a group of closely knit FC individuals. For example, a BC student getting a seat in a university through reservation, implicitly creates friendship ties of that individual with a group of close FC students. Addition of such bridges has two-fold benefits, we term these the *forward breeze* effect and the *backward breeze* effect. The *forward breeze* represents the change in the mindset of the FC, on coming in contact with the BC and the *backward breeze* represents the increased motivation felt by the BC to achieve upliftment, by being influenced by FC members close to them.

Next, our aim is to calculate the gain in the social capital of the BC as a function of the bridges added in the network. There exists no universal definition or technique for measuring social capital [41], this can be attributed to the inherent subjectivity in the concept of social capital. However, in an exhaustive survey [42], the author differentiates between social capital of different types:

1. social capital of an individual with respect to her position in the social network
2. social capital of a group with respect to the underlying relationships within the group
3. social capital of a group with respect to the network topological connections to other groups

In the Caste Reservation scenario, the cumulative social capital to be calculated falls under category 3. Social capital of category 3 was first studied in [43], where the author suggests that the teams with strong outside connections generally performed better compared to groups with weaker connections outside their group. [44] proposed a network measure termed *group centrality* to quantize social capital of type 3. We adopt a modified version of this definition, which fits well with our model. We define the cumulative social capital of BC as the linear sum of social capital of all the individuals present in BC. Further, for every individual u in BC, we assume its social distance (d_u^*) to be a direct measure of its social capital. Lower the social distance of an individual u , higher is its social capital, and vice versa.

As stated earlier, a person from BC getting reservation implies that she has an opportunity to form ties with a set of closely knit FC individuals. But for the sake of our analysis, we will assume that only one tie exists per reservation i.e. all those bunch of weak ties are equivalent to one bridge when calculating the social capital of BC. This is a safe assumption, since, we are measuring social capital as a function of distance, which will rarely change for a pair of nodes in the network when we remove multiple copies of similar functioning edges. However, these multiple edges with respect to one reservation are not equivalent to one bridge in every aspect. For example, presence of multiple weak ties amplifies the strength of the bridge across, in a sense that, even if one link breaks in the future, it does not influence the network topology or social capital significantly.

Next our aim is to analyze the fall in d_u^* ($u \in V_1$) as a function of the number of random bridges added in the system. Most social networks depict scale free degree distribution [45], therefore, ideally we must consider both G_1 and G_2 to be scale free graphs. Empirically, d_u^* falls at approximately the same rate, independent of whether we consider G_1 and G_2 to be scale free graphs or random graphs, as shown in Figure ???. The order and size of graphs G_1 and G_2 are kept constant for plotting both the graphs in Figure ???. Therefore, to make the analysis more tractable, we will consider G_1 and G_2 to be *Erdos-Renyi* random graphs [10] with parameters (n_1, p_1) and (n_2, p_2) respectively. Further, for every $u \in V_1$ and $v \in V_2$, the edge $\{u, v\}$ is present with probability b , which we term as the *bridging probability*.

Mathematical Setup

The two classes BC and FC are represented by two *Erdos-Renyi* random graphs $G_1(n_1, p_1)$ and $G_2(n_2, p_2)$ respectively, where $V(G_1) = \{1, 2, 3, \dots, n_1\}$ and $V(G_2) = \{n_1 + 1, n_1 + 2, \dots, n_1 + n_2\}$. Also, we will be assuming the graphs G_1 and G_2 to be asymptotically large i.e. $n_1 \rightarrow \infty$ and $n_2 \rightarrow \infty$. Every possible edge across the two graphs ($n_1 n_2$ in total) is added with the bridging probability b .

Let u represent an arbitrary node of BC. Our analysis is aimed at calculating d_u^* i.e. the social distance of node u from the FC. We begin by developing the following approximation result.

Lemma 1. $\frac{n!}{(n-l)!} \rightarrow n^l$ when $l^2/n \rightarrow 0$.

Proof.

$$\begin{aligned}
 s! &\approx \sqrt{2\pi s} \left(\frac{s}{e}\right)^s && \text{(Stirling's Approximation)} \\
 \Rightarrow \frac{n!}{(n-l)!} &\approx \sqrt{2\pi n} \left(\frac{n}{e}\right)^n \frac{1}{\sqrt{2\pi(n-l)}} \left(\frac{e}{(n-l)}\right)^{n-l} \\
 &\approx \left(\frac{n}{e}\right)^l \left(1 - \frac{l}{n}\right)^{-(n-l+\frac{1}{2})} \\
 &\approx \left(\frac{n}{e}\right)^l (e)^{l(n-l+\frac{1}{2})/n} \\
 &\approx n^l
 \end{aligned}$$

□

Let M_l represents the total number of possible entry paths of length l with u as one of its endpoint. The next lemma provides an approximation for the constant M_l as a function of l .

Lemma 2. $M_l \approx n_2(n_1)^{l-1}$ when $l^2/n_1 \rightarrow 0$

Proof. To construct an entry path of length l with u as one of its endpoint, we need a vertex from V_2 and a sequence of $l-1$ vertices from $V_1 - u$ i.e. 1 node is to be selected from n_2 nodes and $l-1$ nodes are to be selected from n_1-1 nodes, where these selected $l-1$ nodes can be permuted in $(l-1)!$ ways.

$$\begin{aligned}
 \Rightarrow M_l &= \binom{n_2}{1} \binom{n_1-1}{l-1} (l-1)! \\
 \Rightarrow M_l &= n_2 \frac{(n_1-1)!}{(n_1-l)!} \\
 \Rightarrow M_l &\approx n_2(n_1)^{l-1} && \text{(from lemma 1)}
 \end{aligned}$$

□

Further, let X_l represent the random variable which equals the number of entry paths of length l with u as one of its endpoint. Our next results calculates average number of entry paths of length l originating from the BC node u .

Lemma 3. $E[X_l] = (n_2 b)(n_1 p_1)^{l-1}$ when $l^2/n_1 \rightarrow 0$

Proof.

$$\begin{aligned}
X_l &= \sum_{i=1}^{M_l} Y_i \\
\text{where } Y_i &= \begin{cases} 1 & \text{if } i^{\text{th}} \text{ entry path is present} \\ 0 & \text{otherwise} \end{cases} \\
\Rightarrow E[X_l] &= \sum_{i=1}^{M_l} E[Y_i] \quad (\text{Using linearity of expectation})
\end{aligned}$$

An entry path $P = \langle v_{\alpha_1}, v_{\alpha_2}, v_{\alpha_3}, \dots, v_{\alpha_{l+1}} \rangle$ of length l exists if $(l-1)$ edges $(\{v_{\alpha_1}, v_{\alpha_2}\}, \{v_{\alpha_2}, v_{\alpha_3}\}, \dots, \{v_{\alpha_{l-1}}, v_{\alpha_l}\})$ in G_1 are present and the bridge $\{v_{\alpha_l}, v_{\alpha_{l+1}}\}$ is present. Therefore, the probability that the entry path P exist equals $(p_1)^{l-1}b$.

$$\Rightarrow E[X_l] \approx (n_2 b)(n_1 p_1)^{l-1} \quad (\text{assuming } l^2/n \rightarrow 0)$$

□

We will be interested only in the case where $b < 1/n_2$, since for $b \geq 1/n_2$, expected number of bridges per node in BC will be greater than or equal to 1, which is unrealistic in the Caste Reservation scenario. Henceforth, throughout the analysis, b is assumed to be less than $1/n_2$.

Theorem 1. For a random graph $G_{n,p}$, $p_0 = \log(n)/n$ is the threshold for the property of connectedness.

Proof. A detailed proof is available in [9].

□

Since the two graph considered G_1 and G_2 are connected, the above lemma provides a lower bound on p_1 and p_2 and hence on the density of the graphs G_1 and G_2 . Therefore, $n_1 p_1 > \log(n_1)$ and $n_2 p_2 > \log(n_2)$.

Next we analyze the quantity X_l i.e. the number of entry paths from node u as a function of l . For small values of l the number of entry paths X_l will be negligible ($\ll 1$). Our aim is to find the smallest distance d such that there exist atleast one entry path of length d from node u . This distance d we prove to be equal to $\log_{(n_1 p_1)}(1/n_2 b) + 1$. Henceforth, for the sake of simplicity, we will represent the quantity $\log_{(n_1 p_1)}(1/n_2 b)$ by d_0 .

Theorem 2. Almost always there exist no entry path of length less than or equal to d_0 with u as its endpoint i.e. $X_i = 0$ almost always for $1 \leq i \leq d_0$.

Proof.

$$\begin{aligned}
P(X_i \geq a) &\leq E[X_i]/a && \text{(Using Markov's Inequality)} \\
\implies P(X_i \geq 1) &\leq E[X_i] \\
&= (n_2 b)(n_1 p_1)^{i-1} && \text{(from lemma 3)} \\
&\leq (n_2 b)(n_1 p_1)^{d_0-1} && \text{(Since } i < d_0) \\
&= \frac{1}{n_1 p_1} \\
&< \frac{1}{\log(n_1)} && \text{(from theorem 1)} \\
\implies P(X_i \geq 1) &\rightarrow 0 \\
\implies P(X_i = 0) &\rightarrow 1
\end{aligned}$$

□

Further we will prove that almost always (i.e. with probability close to one) there exist atleast one entry path of length $d_0 + 1$ from u . Hence, proving our claim that $d_u^* = d_0 + 1$.

Lemma 4. *For any random variable X , $P(X = 0) \leq \frac{\sigma_X^2}{\mu_X^2}$, where σ_X and μ_X respectively represent the variance and mean of the random variable X .*

Proof.

$$\begin{aligned}
P(|X - \mu_X| \geq a) &\leq \frac{\sigma_X^2}{a^2} && \text{(Chebyshev's Inequality)} \\
\implies P(|X - \mu_X| \geq \mu_X) &\leq \frac{\sigma_X^2}{\mu_X^2} \\
P(X = 0) &\leq P(|X - \mu_X| \geq \mu_X) \\
&\leq \frac{\sigma_X^2}{\mu_X^2}
\end{aligned}$$

□

Lemma 5. $\sigma_{X_{(d_0+1)}}^2 \rightarrow 0$

Proof.

$$\begin{aligned}
X_l &= \sum_{i=1}^{M_l} Y_i \\
\Rightarrow X_l^2 &= \sum_{i=1}^{M_l} \sum_{j=1}^{M_l} Y_i Y_j \\
&= \sum_{k=0}^l Z_k
\end{aligned}$$

Where Z_k accounts for all $Y_i Y_j$'s, where the i^{th} and j^{th} entry paths have precisely k edges in common. Let $|Z_k|$ represent the number of terms in Z_k 's summation.

$$|Z_0| \geq \binom{n_1-1}{l-1} (l-1)! \binom{n_2}{1} \binom{n_1-l}{l-1} (l-1)! \binom{n_2-1}{1}$$

If none of the vertices in the two entry paths are common, then certainly none of its edges are common either, this gives us the above inequality.

$$\begin{aligned}
\binom{n_1-1}{l-1} (l-1)! \binom{n_2}{1} \binom{n_1-l}{l-1} (l-1)! \binom{n_2-1}{1} &= \frac{(n_1-1)!}{(n_1-2l+1)!} n_2 (n_2-1) \\
&\approx \frac{n_2 (n_2-1)}{n_1 (n_1-2l+1)} n_1^{2l} \\
&\approx n_2^2 n_1^{2l-2} \\
\Rightarrow E[X_l^2] &\approx n_2^2 n_1^{2l-2} (p^{2l-2} b^2)
\end{aligned}$$

The total number of terms in the summation of X_l^2 are M_l^2 i.e. approximately $n_2^2 n_1^{2l-2}$. Therefore, most of the summation terms of X_l^2 fall into the basket of Z_0 .

$$\begin{aligned}
E^2[X_{d_0+1}] &\approx 1 && \text{(from lemma 3)} \\
\sigma_{X_l}^2 &= E[X_l^2] - E^2[X_d] && \text{(By definition)} \\
\Rightarrow \sigma_{X_{(d_0+1)}}^2 &= E[X_{d_0+1}^2] - E^2[X_{d_0+1}] \\
\Rightarrow \sigma_{X_{(d_0+1)}}^2 &\rightarrow 0
\end{aligned}$$

□

Theorem 3. *Almost always there exist an entry path of length equal to $d_0 + 1$ with u as its endpoint i.e. $X_{d_0+1} \geq 1$ almost always.*

Proof.

$$\begin{aligned}
P(X_{(d_0+1)} = 0) &\leq \frac{\sigma_{X_{(d_0+1)}}^2}{\mu_{X_{(d_0+1)}}^2} && \text{(Using lemma 4)} \\
\implies P(X_{(d_0+1)} = 0) &\rightarrow 0 && \text{(Using lemma 3 and 5)} \\
\implies P(X_{(d_0+1)} \geq 1) &\rightarrow 1
\end{aligned}$$

□

Therefore, almost always $d_u^* = \log_{n_1 p_1}(1/(n_2 b)) + 1$. Since, this formula is independent of u , almost all the nodes in BC have social distance $(d_0 + 1)$. Let x represent the expected number of bridges added in the system.

$$\begin{aligned}
\implies x &= n_1 n_2 b \\
\implies d_i^* &= \log_{n_1 p_1}(n_1/x) + 1 \\
\implies d_i^* &= \frac{\log(n_1) - \log(x)}{\log(n_1 p_1)} + 1
\end{aligned}$$

i.e. social distance of any arbitrary node i reduces logarithmically as a function of the number of bridges in the system. Therefore, as we add bridges, their effectiveness in reducing d_i^* also falls. For example, consider d_i^* to be a function x i.e. $d_i^* = d_i^*(x)$,

$$\begin{aligned}
d_i^*(1) &= \log_{n_1 p_1}(n_1) + 1 \\
d_i^*(n_1^{0.25}) &= (3/4) \log_{n_1 p_1}(n_1) + 1 \\
d_i^*(n_1^{0.5}) &= (1/2) \log_{n_1 p_1}(n_1) + 1
\end{aligned}$$

Therefore, to reduce the distance d_i^* by $(1/4) \log_{n_1 p_1}(n_1)$ initially, we need to add $n_1^{1/4}$ bridges. Whereas, to reduce the distance by another $(1/4) \log_{n_1 p_1}(n_1)$, we need to add $(n_1^{1/2} - n_1^{1/4}) \gg n_1^{1/4}$ additional bridges in the system.

Therefore, only the first few bridges are effective in reducing the distance between the two communities, and the edges added later on don't bring a significant change in the social capital of an individual present in BC.

Related Works

Social disparity is a common feature in many countries, and was prominently noticed in the American continents in the form of discrimination against African Americans or the Blacks. A lot of study has been put into perspective in order to gain a better understanding of this phenomenon. A comprehensive study by M.

O. Jackson on Employment and Wages [24] showed that social networks played a major role in determining employment and employability. Groups which remained unemployed found it more difficult to get employment, than those which were already into some form of labor. Studies on black-white links also showed that a great social distance was present between members of the two communities, and this resulted in a wage gap unfavorably inclined towards the blacks who were seen as the disadvantaged community [25]. Studies have also been conducted on the role of social networks in determining an individual's nature of job and wages, and have found that individuals with the same capability end up with very differently ranged incomes due to the ties or friendship links they may have [27], which is a phenomena that we revisit in this paper. Apart from affirmative action in the American continents, discrimination has also been extensively studied in Europe [31], using the multi-national European Social Survey, which quantitatively measured attitudes and feeling using questionnaires, and resulted in similar thesis.

Homophily, which was a key network parameter considered in this paper, has been dealt with in detail in many past studies [3,26,28,29] and its effects on human social networks have also been studied by numerous network experts. These studies have convincingly concluded that homophily plays a determining role in the formation, maintenance and decline of human social networks. In addition, homophily is also seen to heavily influence the spread of information and cooperation through a social network, which has again been analyzed in detail by Nicholas A.Christakis in [36,37]. A strategy similar to the Caste Reservation in India, of intervening and forcing changes in the network structure to spread substantial social influence has been studied in [46,47] as well, although in a different context. The study of cooperation in dynamic networks [38], the cascading effects of cooperation in a network [32], and the various factors determining variation in cooperation across populations [39] are important in analyzing real world networks such as in the Indian scenario, and such studies give a better perspective into networks as a subject in analyzing and determining human behavior in social networks.

Small world networks play a crucial role in this particular study, since we analyze two disparate small world networks. Past research conducted on this topic by Duncan J. Watts and Steven H. Strogatz [34] and Mark D. Humphries and Kevin Gurney [35] investigate many parameters related to small worlds, and help in identifying and classifying them effectively, aiding this study in a significant way.

Conclusion

Indian society has suffered for a long time from a discriminatory system of caste-based segregation that initially arose from concepts of spiritual purity. This led to the concentration of capital and power in the hands of a relatively small number

of people, the supposed upper caste members, and polarized the society along caste-based lines of socio-economically forward and socio-economically backward groups. Policies of affirmative action are crucial in order to bridge this gap between the two classes. In India, the reservation system is one such policy that provides equal opportunities in education and employment to classes that have historically been denied access to them.

In our paper, we looked at the reservation system from a purely network theoretic perspective, by modelling the polarized Indian society in the form of a homophilic network, and considering reservation to be the phenomenon by which link formation between the two polar groups is initiated. We defined the social capital associated with each individual in the backward class as a function of its social distance from forward class, that quantifies an individual's access to education and employment opportunities. We further defined cumulative benefit, or cumulative social capital, as the sum of the individual social capital of members of the backward class. In the proposed model, we were able to study the increase in social capital of a member of the disadvantaged group as a function of the number of inter-group links. We noted that a very small number of links between the two groups are enough for cumulative benefit to increase rapidly. To the best of our knowledge, such a model of the reservation system is the first of its kind.

As a part of future work, we plan on investigating a larger variety of social network topologies wherein such a disparity exists, and apply a similar system in order to test its efficiency. This will allow us to further analyze different parameters involved in the cumulative social capital of a group. Additionally, we plan on studying the social structure within the Indian subcontinent in greater detail, and arrive at a specific percentage of reservation, which we term as the *Ideal/Optimum Number*, which if applied, will cause great amount of upliftment within shortest time.

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